

**REMARKS**

Claims 1-13 are pending in this application. Claim 5 is withdrawn. By this Amendment, claims 1-7 are amended. Claims 1-4, 6 and 7 are amended to recite "an unsubstituted  $\pi$  conjugated organic polymer compound." Claim 5 is amended to recite "heating an unsubstituted  $\pi$  conjugated organic polymer compound, and causing gas molecules of at least one type of compound selected from the group consisting of dyes and charge transport materials to contact and penetrate the unsubstituted  $\pi$  conjugated organic polymer compound." Support for the amendments may be found at least at page 7, lines 24-27, and Examples 1 and 2, of the specification. Now new matter is added.

Applicants appreciate the courtesies shown to Applicants' representative by Examiner Crouse in the April 21, 2009 interview. Applicants' separate record of the substance of the interview is incorporated into the following remarks.

**Rejections Under 35 U.S.C. §102**

**Relying Upon Yu**

Claims 1-4 and 6-13 are rejected under 35 U.S.C. §102(e) as allegedly being anticipated by Yu et al. (U.S. Patent No. 7,098,060).

Yu describes, in relevant part, spin coating or vapor deposition and diffusion of a coumarin green fluorescent dopant onto a thin layer of a poly(p-phenylene) derivative (column 5, line 65 through column 6, line 49).

Claims 1-4 recite a functional layer (claim 1), a light-emitting layer (claim 2), a charge transport layer (claim 3) or a light-emitting layer and a charge transport layer (claim 4), which are formed by causing gas molecules of at least one type of compound selected from the group consisting of dyes and charge transport materials to contact and penetrate an unsubstituted  $\pi$  conjugated organic polymer compound.

As described at page 3, line 27 through page 4, line 4 of this application, unsubstituted  $\pi$  conjugated organic polymer compounds have poor dopability. When used in the production of electroluminescent elements, such elements typically display relatively poor luminescence and luminous efficiency. Also, the luminescent color is limited to the original color of fluorescence.

Applicants discovered, surprisingly, that gas molecules of dyes and/or charge transport materials can be caused to uniformly penetrate and diffuse in high concentration to the inside of the layer containing an unsubstituted  $\pi$  conjugated organic polymer compound. This is accomplished, as detailed in the Examples of the instant application, by heating the unsubstituted  $\pi$  conjugated organic polymer compound, while exposing it to gas molecules of the dye and/or charge transport material. As a result, the electroluminescent elements of claims 1-4 have unexpectedly high luminance and luminous efficiency, and are capable of emitting variable or changing luminescent colors.

Electroluminescent elements made by other methods, such as spin coating or vapor deposition of the dopant (dye and/or charge transport material) as described in Yu, do not cause gas molecules of dyes and/or charge transport materials to contact and penetrate the unsubstituted  $\pi$  conjugated organic polymer compound. Nor do such electroluminescent elements possess the properties of the electroluminescent elements of claims 1-4.

As shown in Example 1 of this application, an electroluminescent element formed by causing gas molecules of 2-(4-biphenyl)-5-(4-tert-butylphenyl)-1,3,4-oxadiazole (PBD) (a charge transport material), to contact and penetrate a thin layer of poly(p-phenylenevinylene) (PPV), emitted yellowish green light, and had a maximum luminance of 3000 cd/m<sup>2</sup> at 14V. The external quantum efficiency was 3.2 lm/w.

Comparative Example 1 of this application shows that an electroluminescent element formed without causing gas molecules of a transport material of dye to contact and penetrate

the thin layer of PPV resulted in an electroluminescent element that emitted yellowish green light and had maximum luminance of 20 cd/m<sup>2</sup> at 14 V, and an external quantum efficiency of 0.7 lm/w.

Comparative Example 2 of this application describes a thin film of PPV formed on a glass substrate, heated and slowly cooled in the same manner as in Example 1 with the exception that perfluorooctane was used instead of PBD as the charge transport material. The thin film of PPV was then measured for ultraviolet, visible and infrared absorption spectra, and no absorption derived from perfluorooctane could be recognized. Penetration and dispersion of the perfluorooctane into the PPV film thus did not occur.

Applicant has submitted a Declaration under 37 C.F.R. §1.132 of Dr. Hiroyuki Mochizuki with additional evidence in support of the unexpected properties of the electroluminescent elements of claims 1-4.

Example A in the Declaration corresponds to Example 1 of this application. Comparative Examples A and A' in the Declaration show that an electroluminescent element comprising PPV as the unsubstituted  $\pi$  conjugated organic polymer compound and PBD as the electron transport/dye material cannot be formed by conventional spin coating or simple contact and penetration methods.

Comparative Example B in the Declaration describes an electroluminescent element made by the method of Example 1 of this application, but where MEHPPV (a substituted  $\pi$  conjugated organic polymer compound) was used instead of PPV as the  $\pi$  conjugated organic polymer compound. The electroluminescent element of Comparative Example B emitted vermillion colored light, and had a maximum luminance of 2500 cp/m<sup>2</sup> at 14 V. The external quantum efficiency was 3.11 m/w.

Comparative Example B' in the Declaration describes an electroluminescent element comprising the same  $\pi$  conjugated organic polymer compound (MEHPPV) and the same

electron transport material (PBD) as Comparative Example B, but manufactured using a conventional spin coating method. The electroluminescent element of Comparative Example B' emitted vermillion colored light, and had a maximum luminance of 900 cd/m<sup>2</sup> at 14 V and an external quantum efficiency of 0.9 lm/w.

The evidence in the Declaration shows that even when manufacturing an electroluminescent element using a substituted  $\pi$  conjugated organic polymer compound, such as MEHPPV, that displays relatively good dopability with conventional methods (such as spin coating and vapor deposition), an electroluminescent element comprising a functional layer which is formed by causing gas molecules of a dye and/or charge transport material to contact and penetrate the  $\pi$  conjugated organic polymer compound possess unexpectedly high luminance and luminous efficiency.

Accordingly, the electroluminescent elements of claims 1-4 are not anticipated by Yu, because the evidence presented in this application and in the Declaration confirms that the electroluminescent elements of Yu would not have gas molecules of dyes and/or charge transport materials penetrated into an unsubstituted  $\pi$  conjugated organic polymer compound, as required by claims 1-4. Claims 1-4 are thus not anticipated by Yu.

Yu also would not have rendered the electroluminescent elements of claims 1-4 obvious. Yu provides no rationale as to how a person of ordinary skill in the art would have modified the electroluminescent elements described therein to have arrived at the electroluminescent elements of claims 1-4. The evidence demonstrates the unexpectedly superior luminance and luminous efficiency of the electroluminescent elements of claims 1-4, compared to electroluminescent elements made by the methods described in Yu. Therefore, there could have been no reasonable expectation of success in modifying the electroluminescent elements of Yu to have arrived at the electroluminescent elements of claims 1-4.

Because claims 6-13 depend from and include the limitations of claim 1, they are also not anticipated by Yu for at least the same reasons.

Relying Upon Tang '357

Claims 1, 2, 6-10 and 13 are rejected under 35 U.S.C. §102(b) as allegedly being anticipated by Tang '357 (U.S. Patent No. 6,066,357) with further evidence provided by Tang '292 (U.S. Patent No. 4,769,292).

Tang '357 describes electroluminescent devices comprising a functional layer formed utilizing a vapor deposition method. For Example, Figures 11A and 11B of Tang '357 show a device wherein a light emitting layer with one or more overlapping dopant layers is exposed to a vaporizable fluid in order to facilitate diffusion of the dopant layers onto the light emitting layer.

As discussed above, vapor deposition does not cause gas molecules of the dye and/or charge transport material to contact and penetrate the  $\pi$  conjugated organic polymer compound as required by claims 1 and 2. Tang '357 thus does not describe each and every feature of claims 1 and 2. Tang therefore does not anticipate claims 1 or 2.

Tang '357 also would not have rendered the electroluminescent elements of claims 1-4 obvious. Tang '357 provides no rationale as to how a person of ordinary skill in the art would have modified the electroluminescent elements described therein to have arrived at the electroluminescent elements of claims 1-4. The evidence demonstrates the unexpectedly superior luminance and luminous efficiency of the electroluminescent elements of claims 1-4, compared to electroluminescent elements made by the methods described in Tang '357. Therefore, there could have been no reasonable expectation of success in modifying the electroluminescent elements of Tang '357 to have arrived at the electroluminescent elements of claims 1-4.

Because claims 6-10 and 13 depend from and include all features of claim 1 they are not anticipated by Tang '357 for at least the same reasons.

Relying Upon Samuel

Claims 1-4, 6-9 and 13 are rejected under 35 U.S.C. 102(b) as allegedly being anticipated by Samuel (U.S. Patent No. 6,313,261).

Samuel describes an electroluminescent device comprising a functional layer that is formed by conventional spin coating (column 7, lines 15-23 and the Examples). As discussed above, spin coating does not cause gas molecules of dyes and/or charge transport materials to contact and penetrate a  $\pi$  conjugated organic polymer as required by claims 1-4. Samuel thus does not describe each and every feature of the electroluminescent elements of claims 1-4. Therefore, Samuel does not anticipate claims 1-4.

Samuel also would not have rendered the electroluminescent elements of claims 1-4 obvious. Samuel provides no rationale as to how a person of ordinary skill in the art would have modified the electroluminescent elements described therein to have arrived at the electroluminescent elements of claims 1-4. The evidence demonstrates the unexpectedly superior luminance and luminous efficiency of the electroluminescent elements of claims 1-4, compared to electroluminescent elements made by the methods described in Samuel. Therefore, there could have been no reasonable expectation of success in modifying the electroluminescent elements of Samuel to have arrived at the electroluminescent elements of claims 1-4.

Because claims 6-9 and 13 depend from and include the limitations of claim 1, Samuel does not anticipate claims 6-9 and 13 for at least the same reasons.

Relying Upon Seo

Claims 1-4, 6, 7 and 10 are rejected under 35 U.S.C. §102(b) as allegedly being anticipated by Seo (U.S. Patent Application Publication No. 2002/0028349).

Seo describes an electroluminescent device having a functional layer formed by vapor deposition (paragraphs [0033] and [0034]). As discussed above, vapor deposition does not cause gas molecules of dyes and/or transport materials to contact and penetrate  $\pi$  conjugated organic polymer compounds as required by claims 1-4. Seo thus does not describe each and every feature of the electroluminescent elements of claims 1-4. Therefore, Seo does not anticipate claims 1-4.

Seo also would not have rendered the electroluminescent elements of claims 1-4 obvious. Seo provides no rationale as to how a person of ordinary skill in the art would have modified the electroluminescent elements described therein to have arrived at the electroluminescent elements of claims 1-4. The evidence demonstrates the unexpectedly superior luminance and luminous efficiency of the electroluminescent elements of claims 1-4, compared to electroluminescent elements made by the methods described in Seo. Therefore, there could have been no reasonable expectation of success in modifying the electroluminescent elements of Samuel to have arrived at the electroluminescent elements of claims 1-4.

Because claims 6, 7 and 10 depend from and include all limitations of claim 1, they are also not anticipated by Seo for at least the same reasons.

Relying Upon Matsuo

Claims 1-4 and 6-13 are rejected under 35 U.S.C. §102(b) as allegedly being anticipated by Matsuo (EP 1143773).

Matsuo describes an electroluminescent element comprising a functional layer formed, in relevant part, by disbursing the dye and/or charge transport material onto an organic polymer layer (paragraphs [0060]-[0075] and [0076]-[0118]). The disbursing step of Matsuo involves the use of a liquid dispersion or solution. This method is thus incapable of causing gas molecules of the dye and/or charge transport material to contact and penetrate the

$\pi$  conjugated organic polymer compound, as required by claims 1-4. Matsuo thus does not describe each and every feature of the electroluminescent element of claims 1-4. Therefore, claims 1-4 are not anticipated by Matsuo.

Matsuo also would not have rendered the electroluminescent elements of claims 1-4 obvious. Matsuo provides no rationale as to how a person of ordinary skill in the art would have modified the electroluminescent elements described therein to have arrived at the electroluminescent elements of claims 1-4. The evidence demonstrates the unexpectedly superior luminance and luminous efficiency of the electroluminescent elements of claims 1-4, compared to electroluminescent elements made by the methods described in Matsuo. Therefore, there could have been no reasonable expectation of success in modifying the electroluminescent elements of Matsuo to have arrived at the electroluminescent elements of claims 1-4.

Because claims 6-13 depend from and include all limitations of claim 1 they are also not anticipated by Matsuo for at least the same reasons.

### **Summary of Arguments**

Claims 1-4 recite an electroluminescent element comprising a functional layer (claim 1), a light emitting layer (claim 2), a charge transport layer (claim 3), or a light emitting layer and a charge transport layer (claim 4), formed by causing gas molecules of at least one type of compound selected from the group consisting of dyes and charge transport materials to contact and penetrate the unsubstituted  $\pi$  conjugated organic polymer compound. None of the cited references describes methods capable of causing gas molecules of dyes and/or charge transport materials to contact and penetrate a  $\pi$  conjugated organic polymer compound. Thus, none of the references describes a functional layer, charge transport layer, or light emitting layer formed by causing gas molecules of dyes or charge transport materials to contact and penetrate a  $\pi$  conjugated organic polymer compound.

Nor do the electroluminescent elements described by the cited references possess the unexpectedly high luminance and luminous efficiency of the electroluminescent elements of claims 1-4. The Examples of this application and the evidence in the Declaration under 37 C.F.R. §1.132 of Hiroyuki Mochizuki provide evidence of this unexpectedly superior property of the electroluminescent elements of claims 1-4.

**Rejoinder**

Because the claims were subjected to a restriction between product and process claims, and because the product claims are allowable, as discussed above, the process claim (claim 5) must be rejoined and considered.

Applicants request that claim 5 be rejoined and considered.

**Conclusion**

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 1-13 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,



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